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Construction Technology and its Use in Solving Geometric Problems

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Annotation: This article discusses the active research position of students, the ways of forming the subject's views in the educational process by constructing geometrical issues using the construction technology.

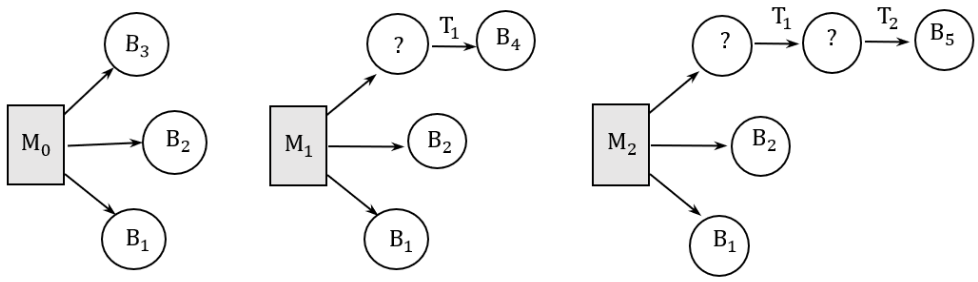
Keywords: geometric problem, construction technology, problem formulation, combined problem, linear problem.

If in the lower stages of human civilization, activities aimed at educating and educating a person were organized on the basis of simple, very simple requirements, today very strict and complex requirements are imposed on the organization of the educational process. For example, the social need to train qualified specialists who can work with complex equipment and positively solve problems that arise even in emergency situations requires the organization of the educational process on the basis of a technological approach.

Our country has accumulated certain experiences in educational technology, which, as a result, creates an opportunity to achieve certain efficiency in educational processes, as well as to educate a well-rounded individual and qualified specialist.

Currently, the following types of technology are widely used: “Problem-based learning”, “Modular learning”, “Developmental learning”, “Differential learning” and so on. In this article, we are going to talk about the construction technology and the technology of constructing geometric problems from it and its role in increasing the methodological training of future mathematics teachers. Let's construct a geometric problem as follows: we replace one of the given ones in the problem with a theorem (definition, property). Thus, we get another problem that is more complex than the given problem, and that, by applying the above theorem (definition, property), leads to the simple problem given. Based on this method of constructing a problem, all problems related to geometry can be included in one of the following three constructions:

1. Problems that are formulated by replacing one of the given variables or its derivative several times (linear problems):



(Here and hereinafter: T_i– theorem, B_i– given in the problem, M_i– problem)

Solution to the problem:

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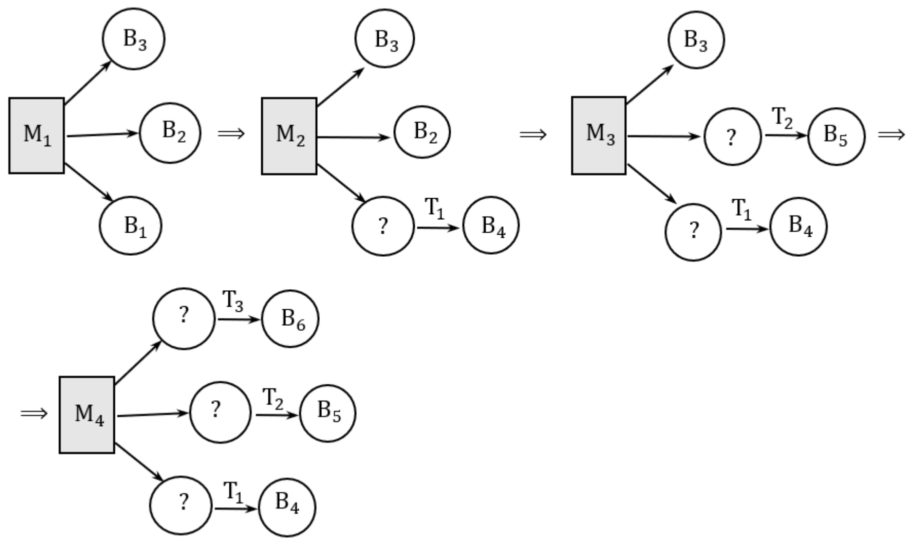
$$M_0 \xrightarrow{T_1} M_1 \xrightarrow{T_2} M_2$$



2. Problems that are formed by replacing several of the given ones in the problem at the same time (branched problems):

Solving the problem M_4:

$$M_4 \xrightarrow{T_1} M_3 \xrightarrow{T_2} M_2 \xrightarrow{T_3} M_1$$

3. Problems formed by applying the first and second methods (combined problems).

Thus, we will describe in general terms the method of forming a complete system of problems (using the example of linear problems).

1. After passing the new theoretical material, a simple problem is selected from the topic for direct application of the new theory. (For example, in the topic "The first sign of equality of triangles", triangles with two congruent sides and the angles between them are taken and a problem is selected to prove their equality.)
2. In this problem, we replace one of the given conditions $\boldsymbol{a_1}$; $\boldsymbol{a_2}$; $\boldsymbol{a_3}$;…$\boldsymbol{a_n}$; with a condition $\boldsymbol{b_k}$ using a theorem T_1discussed in this topic or in previous topics, and we get a new problem that is more complicated than the given problem. As a result of applying the theorem T_1 to the condition $\boldsymbol{b_k}$ in this problem, the condition $\boldsymbol{a_k}$ is replaced and we return to the original problem.

Example. Initial problem: "Given the triangles ABC and $A_1B_1C_1$. $AB = A_1B_1$; $AC = A_1C_1$; It is known that angle A is equal to angle A_1. It is necessary to prove that triangle ABC is equal to triangle $A_1B_1C_1$."

Using the theorem on adjacent angles, replacing the condition "angle A is equal to angleA_1" with the condition "angle KAB is equal to angle $K_1A_1B_1$" (Figure 1), we obtain the following derivative problem: Given triangles ABC and $A_1B_1C_1$. $AB = A_1B_1$; $AC = A_1C_1$; It is known that angle KAB is equal to angle $K_1A_1B_1$. It is necessary to prove that triangle ABC is equal to triangle $A_1B_1C_1$.

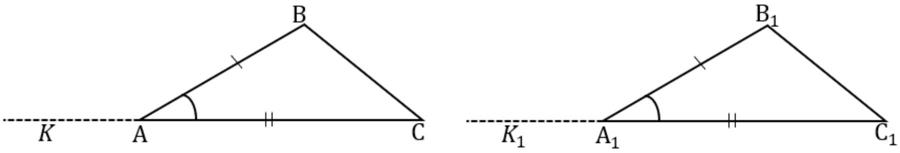
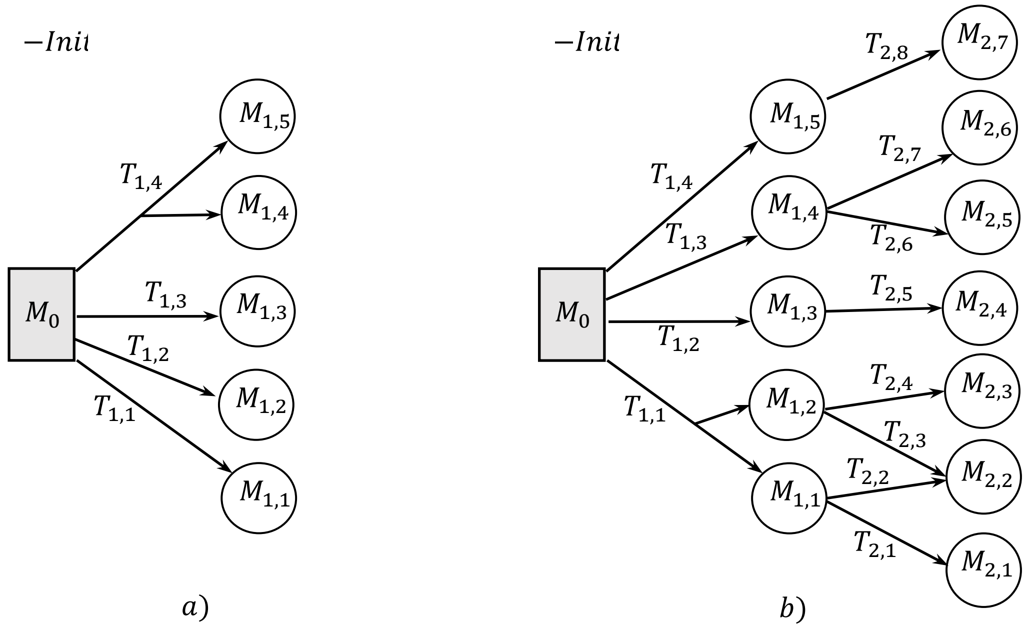


Figure 1

If we apply the theorem about adjacent angles to the condition in the derivative problem, “angle KAB is equal to angle $K_1A_1B_1$”, we replace this condition with the condition “angle A is equal to angle A_1”, and we get the original problem again. The solution to this problem is very simple.

3) In the same way, using the theorems $T_{1,i}$, we construct a set of problems of the first complexity level, a) $M_{1,i}$:



Then, using the theorems $T_{2,i}$), we construct a set of problems of the second complexity level, b) $M_{2,i}$:

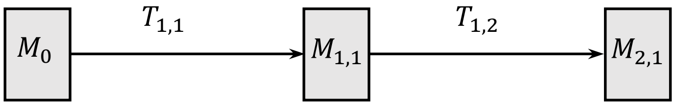
It should be noted that when constructing problems of the second complexity level, one theorem can be used twice.

4) Thus, a system of problems $[M]$ is constructed, which is reduced to a simple problemM_0.

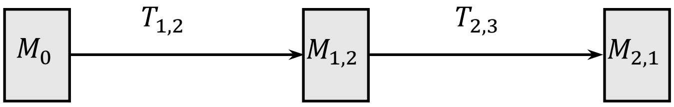
So, what is the characteristic feature of problems of the same level? If we look at the structure of the system of problems, we can notice that all problems) $M_{1,i}$ (first-level problems) are located only one step away from the initial simple problem, and, accordingly, all problems) $M_{2,i}$ (second-level problems) are located two steps away from the initial simple problem.

Students who have learned to formulate their own problem using this method can easily construct an independent analytical reasoning chain even at the stage of searching for ways to solve a problem that is “unfamiliar” to them.

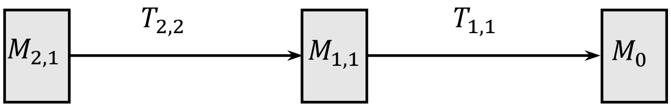
When formulating a problem $M_{2,1}$, a student can choose one of the following reasoning paths:

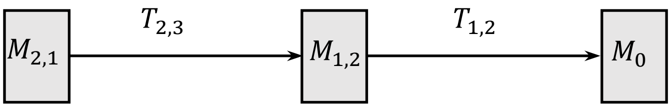


or



Solving the problem $M_{2,1}$ is done in reverse order:





Thus, this process has a reverse order to the problem-solving procedure.

It should be noted here that the system of symbols used above is not invariant in formulating and solving problems. Students can independently construct a system of symbols that is convenient and understandable for them in the lessons. This is a principled approach that allows students to independently determine new symbols and the relationships between them, which are reinforced by the model, and serves as an important factor in the formation of mathematical thinking and mathematical language.

“Own” symbols, as a form of transition to generally accepted symbols, allow the student to record the relationships between the individual components of new concepts that he has discovered for himself in a convenient and individual form.

This method cannot be simply memorized by the student, but can be mastered in the process of individual or joint (pair or group) activity, as well as in the process of constructing a system of problems, requiring an active research position from the student, and helps to form the student's subjective views on the learning process. The formation of such a position is carried out by involving the student in research activities.

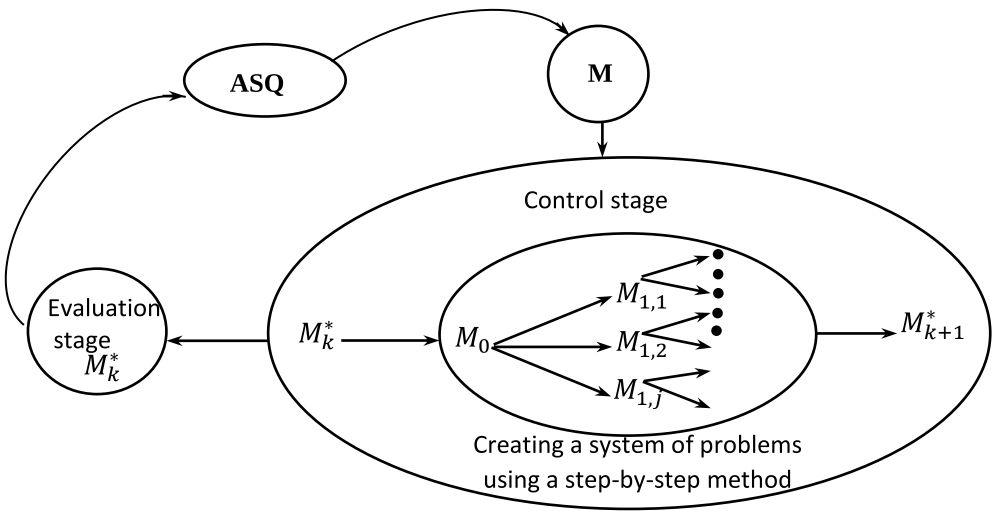
In higher educational institutions, research activity, as well as educational activity, is formed in students. Therefore, the technology of planning and organizing lessons should be built on the principles of educational activity.

Students, by formulating a problem themselves, independently encounter such a problem (or such a problem is posed by the teacher as a continuation of a system of problems), the solution to which goes beyond the scope of the studied and mastered method, geometric concept or assertion (problematic problem). The knowledge available to students is not enough to solve this problem. As a result, such a method creates a need for new knowledge in students. This fact justifies the possibility of implementing the process of teaching geometry by formulating problems using the method of step-by-step solving of geometric problems from the reverse.

Thus, a problematic problem is found. During the initial acquaintance of students with its conditions, it consists of a purely practical problem. In the process of analyzing the conditions of the problem and searching for ways to solve it, students begin to understand what exactly prevents the problem from being solved (what is missing for solving it). So, what information did the author “hide”? With the help of what knowledge did he achieve this?

By searching for answers to such questions, an educational problem is formed in students. This problem is theoretical in nature and significantly differs from the practical problems that students have been analyzing so far.

Students express the method, relationship, sign, property or definition found in the process of solving the educational problem (in groups, pairs or individually) in the form of a model. Then these constructed models are considered and analyzed: important and unimportant signs are separated, errors are corrected, a generalized model is created or several variants of the presented models are left. After that, it is necessary to involve the students themselves in the activity of forming problem-solving skills using this model. A specific feature of geometric topics is that the found model can only be applied to solving simple problems or to solving problems where the same method (relation, sign, property or definition) is used many times, which does not fully strengthen the skill of using the found model. Therefore, in order to strengthen the skill of using this model in students and automate it, it is necessary to teach them to apply the found model to problems that are solved using other models. In fact, it is precisely this method - strengthening the skill of using both new and old models in solving problems and automating it - that allows students to systematize their knowledge more effectively. However, such a combination of using models in one problem is always given in textbooks. Therefore, the teacher should pay attention to choosing a system of problems based on this law. The methodology of the reverse step-by-step formation of the method of action (style) allows students to involve themselves in the activity of constructing a system of problems that are solved using a new model. In this case, each problem is formed in accordance with the individual characteristics of students, that is, their level of mastery of the subject, the level of understanding of the content of new and previous material. Thus, students consciously engage in cognitive activity and control the level of complexity of the lesson



The main technological chain of studying geometric topics through the method of forming the step-by-step implementation of solving geometric problems from the reverse.

ASQ - the formulation of the educational problem, M - modeling.

Let us explain this scheme using the terms and symbols of the theoretical description of the methodology for the step-by-step formulation of the method for solving geometric problems from the reverse:

1) From the main technological chain it can be seen that the formulation of the educational problem first requires the formulation of a problematic practical problem M_1^* , which requires the acquisition of new knowledge. At this stage, students evaluate the problem M_1^* from the following positions:

a) through the similarities and differences of the problem M_1^* from previously solved problems;

b) by trying to solve the problem M_1^* based on their existing knowledge;

c) by isolating the existing knowledge and unknown knowledge necessary to solve the problem;

2) At the stages of setting and modeling the educational problem, students set themselves a specific theoretical problem and express the ways and methods of solving it in a schematic form or in the form of a model.

3) At the control stage, students begin their work by isolating a simple problem M_0, aimed at solving the problem M_1^* and directly applying the “discovered” theorem, property, reasoning, etc. Then, using the “step-by-step method”, a system of problems is constructed and their solution is carried out. In the process of constructing and solving such problems, students independently or with the help of a teacher find a new M_2^* problematic problem (or several such problems at once). In this case, all the problems found are recorded and one of them is worked on, the solution of which: a) should be in the area of the closest development of the students' knowledge; b) should not contradict the logic of the construction of geometry. Then students again proceed to the evaluation stage.

Thus, the study of the geometry course gradually becomes more complicated, which ensures:

- a relatively complete formation of educational activity in students whose educational activity has not yet been fully formed, as well as an appropriate mode of work with students who have already formed such activity;
- the continuity of the process of formation of geometric thinking of students;
- achieving a level of conscious understanding of the idea of \u200b\u200bdeductiveness in geometry;
- Systematization of students' knowledge, etc.

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